DOCUMENT RESUME

ED 115 190 HE 007 037

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TITLE Measuring Student Success: A Systematic Statistical Analysis. Evaluation Report. Programme on Institutional Management in Higher Education.
INSTITUTION Organisation for Economic Cooperation and Development, Paris (France). Centre for Educational Research and Innovation.
PUB DATE Jan 75
NOTE 19p.; Paper presented at the General Conference of Member Institutions (2nd, Paris, France, January 1975)

EDRS PRICE MF-$0.76 HC-$1.58 Plus Postage
DESCRIPTORS *Higher Education; *Measurement Techniques; *Models; Planning; *Statistical Analysis; *Success Factors; Systems Development
IDENTIFIERS Austria; *University of Linz

ABSTRACT

This document summarizes a project that measures students' results by statistical analyses of examination data at the University of Linz, with special reference to the possibilities of institutionalizing the methods obtained. The survey included 609 students enrolled in business studies from 1966 to 1969. Studies at the university are pursued in two stages, four semesters each, that lead up to what may be translated as half-degree and degree examinations. Student success was measured in terms of: (1) the behavior of a student intake chosen from a field of study; (2) new methods of analysis usable in an institutionalized system; (3) models designed to forecast a student's probable success or failure; (4) a basis for decisions to improve conditions of study, with the help of a simulation model; (5) an attempt to define a global, theoretical model for the study sequence; and (6) proposal for an institutionalized system for the whole of Australia to enable examination data to be processed by a central computer. While the possibility of applying the Linz model depends on the existence of relatively well-structured study regulations, the system might also be slightly amended to apply to any university, provided that the student was obliged to report before the end of his studies. (Author/KE)

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Paris, 17th December, 1974

Or. Fr.

PROGRAMME ON INSTITUTIONAL MANAGEMENT IN HIGHER EDUCATION

MEASURING STUDENT SUCCESS: A SYSTEMATIC STATISTICAL ANALYSIS

Evaluation Report
on the research work carried
out at the University
for Economics and Social
Sciences in Linz.

by

Richard Bretscher

Second General Conference of Member Institutions
(Paris, 20th-22nd January, 1975)

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Note by the Secretariat

One of the principle aims of the Second General Conference of Member Institutions of the Programme on Institutional Management in Higher Education is to evaluate the methods and results proposed by the three research groups which completed their work in 1974. A specialist was appointed for each research group to provide an independent evaluation of the work before the Conference. The guidelines the experts were asked to follow emphasized the need to evaluate the scientific importance of the results, their practical use for the improvement of institutional management in higher education, their transferability from one institution or country to another, and the comparability of the methods and results with those put forward by other groups working in the same field. In addition, the evaluators were asked, on the one hand, to summarise the results of each project so as to give readers who had not had the time or opportunity to read the final report a clear and precise idea of its content and, on the other hand, to make specific suggestions for subsequent analyses in the same or related fields.

The present Report evaluates the work of Research Group No. 1: "Measuring student success: a systematic statistical analysis", carried out at the University for Economics and Social Sciences in Linz.

The Centre for Educational Research and Innovation wishes to extend its warmest thanks to the author.

Measuring student success:
A systematic statistical analysis

Research carried out at the University for Economics, Linz

Evaluator's Report

This study was carried out by:

MR. TRAUNMULLER, professor of computer science at the University of Linz, previously in charge of the data processing department of the administration, and by

MR. K. STRIGL, psychologist, adviser on studies at the University of Linz.

The information was processed on the relatively modest equipment available at the University computer centre, namely an IBM 1130 with a capacity of 16 K words of 16 bits, an integrated 512 K words disc unit, a card reader, a card reader/punch, a printer and 2 interchangeable disc units each with a capacity of 512 K words.

A: SUMMARY OF THE WORK

I: Definition of Aims

On the basis of their terms of reference, the authors defined their aims as follows:

To measure students' results by statistical analyses of examination data at the University of Linz, with special reference to possibilities of institutionalising the methods obtained.

This aim was subdivided into 6 points:

1) Detailed analysis of the behaviour of a student intake chosen from a given field of study.
2) Investigation of new methods of analysis usable in an institutionalised system.
3) Investigation of models designed to forecast a student's probable success or failure.
4) Use of study programmes as a basis for decisions to improve conditions of study, with the help of a simulation model.
5) Attempt to define a global, theoretical model for the study sequence.
6) Proposal for an institutionalised system for the whole of Austria to enable examination data to be processed by a central computer.

The study must only use measurable data obtained as a by-product of administrative procedures and will therefore exclude any studies or surveys relating to qualitative criteria, such as social environment, etc.

II - BRIEF DESCRIPTION OF THE EDUCATIONAL INSTITUTION

The University of Linz was founded in 1966/67.

The survey relates to 609 students enrolled for business studies during the years 1966-1967, 1967-1968 and 1968-1969, excluding those who left Linz to register at another university or in another field of study.

Studies are pursued in two stages, each of 4 semesters, which lead up to what may be roughly translated as half-degree and degree examinations. The first stage provides a general background and specialisation does not begin before the second stage.

Half-degree examinations can only be taken during the 4th semester, and the present paper focuses on 4 separate examinations conducted by the professors of the subjects concerned.

Degree examinations can only be taken at the end of the 8th semester, before an examining board covering 4 fields of study several of which offer a choice of subjects.

In order to qualify for these examinations the student must have obtained a certain number of practical work certificates, and this he can do at virtually any time. Marks are also awarded on these certificates.

It will be noted that students cannot attend courses in the second stage until they have passed the half-degree examinations.

It may also be mentioned that the usual practice is not to send marks to the administration unless they are satisfactory.

Although the closing date of the survey, i.e. 31st December, 1972, fell later than the minimum period required for the groups of students in the survey to complete their studies, 145 students (i.e. 24 per cent of the population considered) had not yet finished although they had obtained their half-degrees and 14 per cent of the students, while still enrolled had not yet obtained their half-degrees and were therefore considered to have failed.

III - DETAILED ANALYSIS OF THE BEHAVIOUR OF A STUDENT INTAKE CHOSEN FROM A FIELD OF STUDY: INVESTIGATION OF METHODS OF ANALYSES

The student population in the survey, as stated above, consists of the students enrolled for business studies in 1966-67, 1967-68 and 1968-69, i.e. 609 students (Cf. 2.2).

In aggregate, it may be said that:

25 per cent of students obtained their degrees,

24 per cent were still at university having obtained their half-degrees,

51 per cent either abandoned their studies or were still enrolled but had not obtained the half-degree.

From a factorial analysis covering a total of 48 variables listed in detail in Annex 3.7 of the original report (for example: award of the degree or half-degree, mark obtained for certificates and relevant semester mark obtained in examinations and relevant semester, number of optional certificates and average mark obtained during the first 4 semesters - by semester, number of compulsory certificates obtained during the first 4 semesters - by semester), it emerges that the strongly correlated variables are

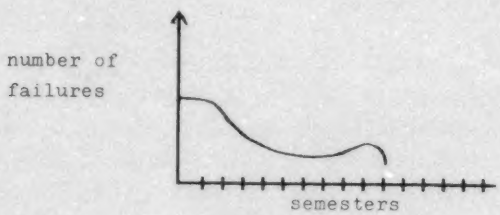
the marks obtained and the semesters when the certificates were obtained or the examinations taken.

In conclusion, the authors consider that success in a course of study depends both on the rapidity with which it is taken and on the quality of the results obtained, these two strongly correlated factors having to be interpreted as a single joint factor (cf. 2.4.1).

The analysis of the duration of studies shows that of the 255 students awarded the half-degree, 65 per cent obtained it in the 4th semester, while of the 112 students who gained degrees, 73 per cent graduated in the course of the 9th or 10th semester. Delays in the study programmes occurred mainly during the second stage of study (Cf. 2.4.2).

The analysis of drop-outs shows that of 224 students who gave up their studies, 214 did so during the first stage of study and that 202 students had still not even obtained certificates for practical work. Once the half-degree has been passed, very few students give up (Cf. 2.4.2.4), although it is probable that some of those who did not finish their examinations by 31st December, 1972 will also drop out.

The result is the following curve:



The analysis of practical work certificates shows that out of a total of 609 students, 196 had not obtained any certificates at all (mostly older students) and that most certificates were obtained at the beginning of the two stages of study (Cf. 2.4.3.1).

After further analyses, 3 patterns of study emerge:

1) Successful students, i.e. those who obtain their degrees in the minimum scheduled time; the feature of this group is its high level of activity with regard to both practical work - compulsory and optional - and examinations, at which good marks are obtained.

2) Slower students who have to repeat more examinations and obtain less satisfactory results and who differ from the first groups as regards the time when they take their practical work certificate and sit for examinations in certain areas of study, and the fact that these examinations are taken later.

3) The failures, who pass no practical work certificates or examinations and are sometimes eliminated in certain compulsory subjects (Cf. 2.4.4.2).

Among the students obtaining their half-degree, the 3 groups were represented as follows:

1) successful: 190

2) slower: 81

3) failures: 229

(Cf. 2.4.4.3)

The degree was obtained by 62 per cent of those who were successful at the half-degree stage, and by 27 per cent of the slower students.

However, 36 per cent of successful students in the first stage fell behind in the second stage (Cf. 2.4.4.4).

The various statistical tests are described in detail in Chapter 3.4. Mainly because of the small numbers involved, no attempt was made to standardize the examination results.

Students who switch to another field of study may be divided into two groups:

a) those who switch only once (wrong initial choice);

b) those who switch often, are almost always slow students and finally drop out (people who simply wish to retain their student status) (Cf. 2.4.5).

In conclusion, it emerges from the various analyses that:

1) Student behaviour remains more or less constant;

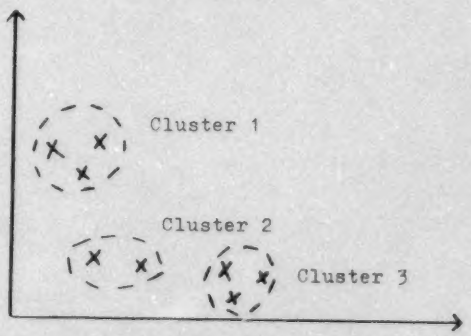
2) There are indicators which enable a distinction to be made between the various behaviour groups, and this leads the authors to think that it should be possible to make an individual forecast as to the chances of success or failure fairly soon after studies have begun.

Analysis of the study sequence by the cluster method (Cf. 3.5).

Generally speaking, these methods enable individuals belonging to a given population to be grouped mathematically on the assumption that an individual always belongs to the group closest to him. There are several methods but the advantage of the one evolved at Linz is that there is no need to specify a distribution function to be optimised nor is there any need to know the distribution of the individuals in the population beforehand or to fix the number of groups to be found.

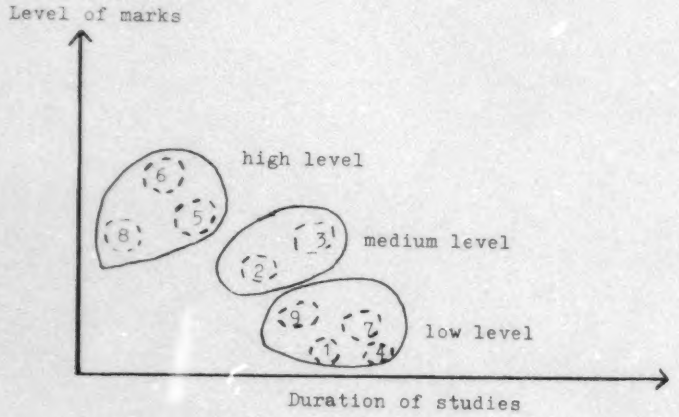
In short, the method is to demonstrate the existence of clusters of dots without assuming any particular distribution at the outset.

Example:



Applied to 340 students who had obtained at least 1 practical work certificate, this method gives the following results:

The population was divided into 9 clusters. An analysis of these clusters on the basis of their marks gives results similar to those recorded at the time the certificate was obtained, which means that these two criteria can be combined and the clusters divided into high-level, medium-level and low-level types.



Once these clusters have been determined, they can also be analysed according to other criteria, such as marks obtained by subject areas, choice of subject area in relation to time. and determination of the "compulsory subject areas".

With reference to the initial assumption of 3 behaviour groups, it must be said that although the failures are again very clearly differentiated from the others, the successful and the slower students sometimes tend to merge inside the groups.

It is also found that the students with the best marks are not the most rapid and, conversely, the most rapid do not obtain the best marks.

It is also possible, from the pattern of marks, to detect groups of students of the "arts" type and those who have a more mathematical bent.

Among the failures, there are groups with normal patterns of marks, except in one or two specific examinations.

It is also apparent that, with one exception, the students in the first 4 groups obtained their certificates in a specific order, whereas in the bad groups there was no systematic order, whence the conclusion that "good" students organise their studies intuitively, which is not the case as far as "bad" students are concerned (cf. 2.5).

IV. INVESTIGATION OF MODELS DESIGNED TO FORECAST A STUDENT'S PROBABLE SUCCESS OR FAILURE

The assumption that student behaviour is consistent and that it is possible to make a distinction between behaviour groups, suggested the idea of attempting to allocate students to their nearest groups, given that the chances of success or failure in these groups are known.

Two models were decided on:

a) a variance model,

b) a friction model.

The variance model is based on the cluster method in the sense that groups are defined and individuals allocated to the nearest group. The variables used to establish the groups of successful students, slower students and failures are the number of compulsory certificates obtained, the marks awarded and the relevant semester, the number of optional certificates. In one version of the model these variables were all given the same significance, while in another version they were weighted. In the event of a disparity in the forecasts between the two versions, a warning message is printed.

Forecasts concerning the half-degree

The survey covered a batch of 100 students in 1969/70 (whose real results were known) on the basis of groups determined from the data for the 1966/68 batches. The forecasts were confirmed in the following proportions:

68 per cent of forecasts carried out during the 1st semester,
70 per cent " " " " " " 2nd " ,
71 per cent " " " " " " 3rd " ,
63 per cent " " " " " " 4th " ,
63 per cent " " " " " " 5th " .

It should be noted that the behaviour group a student will belong to can be forecast by the 1st semester. If it is only a question of determining success or failure, the accuracy of forecasts increases to between 73 and 81 per cent.

On the other hand, failures were very inaccurately forecast in this example. According to the authors, the reason for this might be that the behaviour of the 1969/70 students changed from that of the previous groups or that the groups were badly defined.

Forecasts concerning the degree. These were based on the 1966/68 batches and the results are not so good (between 62 and 66 per cent for successful students, and 84 per cent for slower students). Here it would seem that the samples were too small and that the fact that the studies were not always completed influenced the results unfavourably (cf. 2.6.1 and 3.6).

The friction model is designed to measure the pace of studies on the assumption that they can be delayed by various negative factors (difficulty in adapting, etc.) which are expressed by a friction factor. This factor is determined on the basis of marks, number of certificates and relevant semester.

As regards the half-degree, the following results were obtained:

71 per cent of forecasts in the 1st semester were confirmed
67 per cent " " " " 2nd " " "
72 per cent " " " " 3rd " " "
72 per cent " " " " 4th " " "

The forecasting of failures was more successful than in the variance model (41 per cent).

Forecasts concerning the degree are unsatisfactory (cf. 2.6.2 and 3.6).

In conclusion, the authors are of the opinion that forecasting is possible very soon after the beginning of studies and that the findings of these two models, based on the feasibility of systematic and institutionalised analysis of observed data concerning certificates awarded and examinations passed are better than those obtained from other tests, particularly psychological tests.

Forecasts can be either individual or collective. In the first case, the problem is to decide the form in which the information could be communicated either to the students themselves, or to the academic advisory service. Collective forecasting could be of value as a guide to changes that might have to be made to the system of studies, provided such information could be obtained rapidly. Another possible measure might be the systematic introduction of a trial semester to enable students to adapt (cf. 2.6.3).

A comparison between the results of certain examinations and the size and rate of occupation of premises did not produce any meaningful results. It should be said that conditions at the University of Linz, which was built in 1966, are ideal and that the premises are invariably not used to their full capacity (a maximum of 87 per cent of the premises are used at any given time during the week and a maximum of 42 per cent of total capacity) (cf. 2.7.1).

However, it was noted that the personality of the examiner is important. This becomes obvious when one compares the marking in parallel examinations where several professors hold orals on the same subject. Average marks and their distribution differ considerably according to the character and age of the examiner, the status of the course (compulsory or optional), etc.

The authors do not, however, suggest any way of reducing the influence of these subjective factors (cf. 2.7.2).

V. THE USE OF STUDY PROGRAMMES AS A BASIS FOR DECISIONS TO IMPROVE CONDITIONS OF STUDY, WITH THE HELP OF A SIMULATION MODEL

The following variables were used in this micro simulation model which was tested on students of computer science:

- number of students
- distribution of students by semester of study
- students' work behaviour
- study schedules
- choice of study schedules
- long-term courses available
- choice of courses
- courses at present available
- present choice of courses
- features of present courses
- results

Using the data obtained via the examination system, it is possible to determine statistically the parameters for the choice of the study schedules, the choice of subjects and the work behaviour of students (examination results and relevant semester). Similar values can be obtained for the characteristics of subjects particularly new subjects.

The results covered:

a) for each subject in the study schedule: the number of students who took the subject, the average semester in which the certificate was obtained, the average mark and the standard deviation of marks;
b) study results according to students: successes, setbacks and failures, setbacks being expressed by a predetermined value.

The results given in the original paper are intended as an illustration; the implementation of a system of this kind and the interpretation and reliability of the results will depend on further in-depth research (cf. 3.7).

VI. ATTEMPT TO DEFINE A GLOBAL THEORETICAL MODEL FOR THE STUDY SEQUENCE

The factors influencing the study sequence may be classified as follows:

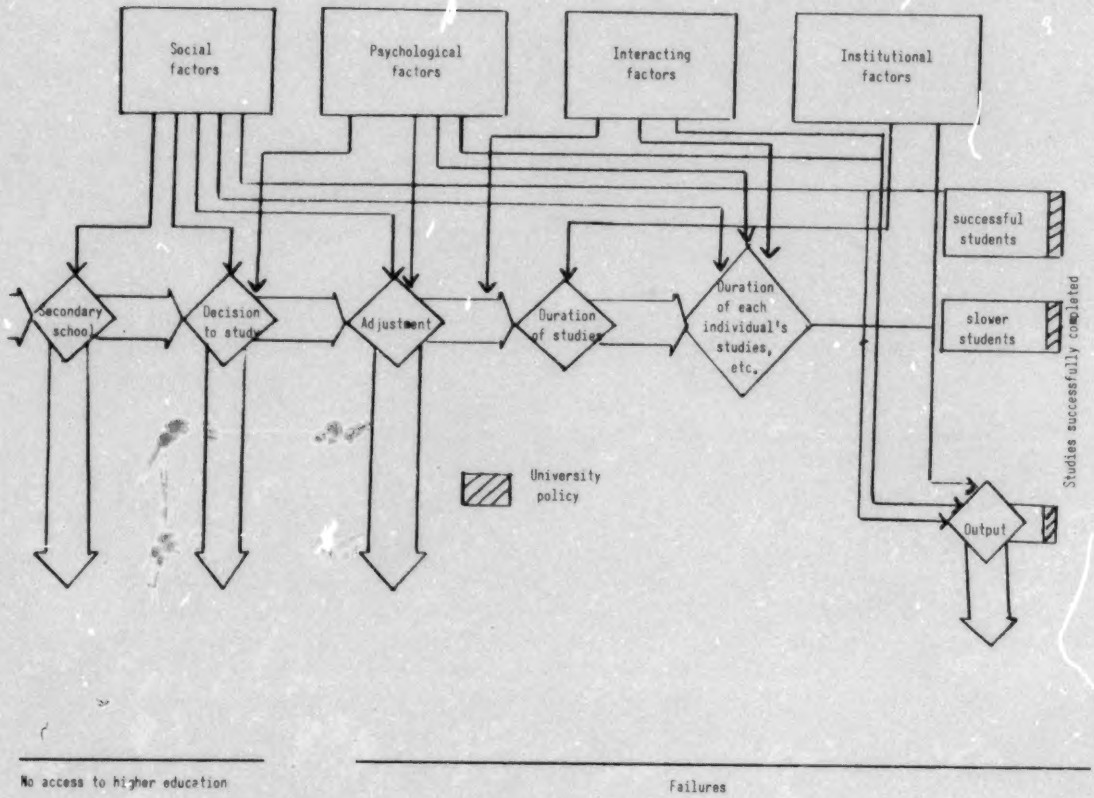
1) Personal factors:
   a) social factors (social background, degree of social isolation, etc.)
   b) psychological factors (intelligence, personality, character, interests, motivations, etc.).
2) Institutional factors:
   a) objectively measurable factors (study regulations, courses available, examination marks)
   b) subjectively measurable factors (teaching methods, behaviour of teachers, atmosphere at the university, etc.)
3) Interactive factors:
   (contacts with the environment, contacts with teachers and fellow students, relations with parents, spouse, etc.).

A number of hypotheses may be put forward regarding these factors:

H1: Social factors prevent a large number of potential students from going on to higher studies.
H2: The decision to study or not and the choice of the field of study depend on social and psychological factors.
H3: The student's success is determined by his adjustment to higher studies during the first few semesters.
H4: Adjustment is determined primarily by psychological factors and secondarily by institutional and social factors.
H5: If the adjustment is successful, psychological factors will determine the duration of studies.
H6: The average duration of studies is determined by institutional factors.
H7: If problems arise during studies, psychological and social factors come into play. If these problems are not resolved, institutional factors may cause studies to be broken off.
H8: Institutional measures can be taken to prevent such problems from resulting in a student's failure.
H9: The cybernetic aspect of the system entails a very long reaction time. It is therefore necessary for external bodies to support the introduction of any changes in the system.

Note: The measurable data used here are simply those which are normally obtained as by-products of administrative procedures.

This model may be pictured as a system of filters or as a model of friction in a pipe network, (cf. 2.8).



VII. PROPOSAL FOR AN INSTITUTIONALISED SYSTEM FOR THE WHOLE OF AUSTRIA TO ENABLE EXAMINATION DATA TO BE PROCESSED BY A CENTRAL COMPUTER

The processing of the data for the present study was carried out with a small computer, using a data bank specially developed at Linz and written in FORTRAN IV.

The chief source data is the university administration.

The data bank comprises the following sets of information:

- students (personal data, previous studies, fixed data and changing data);
- studies (fields of study, examinations, etc.).
- teachers;
- enrolments for semesters;
- timetable of courses;
- premises.

Access to this information is by way of indexes constructed on registration numbers, names of students and course codes.

The system is supplemented by a file (groups and elements) and a code catalogue.

Chaining of information is centred chiefly on the student.

Input mainly takes the form of punch sheets .

A data processing programme to support the analysis of administrative procedures has been developed at Linz. It shows the chaining of the different operations, the information flow, the documents used and the processing times, all within the examination context.

A simplified system of dialogue has also been introduced enabling the combinations of information retrieval keys and counts to be represented symbolically. (cf. 3.1 and 3.2).

The data bank for study programmes enables student information to be linked to course information. A data base of this kind should make it possible to record patterns of information linking the different courses by AND-OR relationships and showing the student's future courses, examinations and practical work. In addition there are a number of problems to be settled, such as alternative courses, optional course, parallel courses, courses appearing in different places in the same study programme or in different programmes, courses which are a prerequisite of admission to other courses, several courses satisfying the requirements of a study programme, etc. These problems have been partially resolved by means of chainings and various coding schemes in the data.

This data base performs a central function in a university data processing system. It has, to provide the link between the study programme and the courses actually offered in a given period and, also to assign an examination or practical work result to a student with a comprehensive check as to whether all the conditions of the study programmes have been met.

In addition to the operational function of this data base, it should also be used to plan teaching and evaluate the instruction offered against the requirements of the study programmes. The operational data should therefore be supplemented by key digits designed to describe the individual features of any given programme on comparable lines: e.g. the number of semesters to be spent on a scheduled course, the number of hours per week, practical work, the number of possible choices, etc. At the same time, similar key digits may be inserted in the course file, enabling all sorts of analyses and comparisons to be made between different study programmes or between the courses required by a programme and the courses actually available. These analyses are valuable tools

for the management and organisation of teaching and for optimising the student capacity of the university (cf. 3.3).

Using the two data bases at Linz as the starting point, the authors recommend the institution of a similar system for the whole of Austria and have drawn up a data bank project applicable to examinations. Details of this data bank project appear in Chapter 4 of the original text.

B: COMMENTS BY A NON-AUSTRIAN COMPUTER SCIENTIST

The few comments that follow were prompted by a number of interesting discussions which the author was privileged to have with his Austrian colleagues in the course of several meetings. They are, so to speak, the joint product of an exchange of views which was also intended to go beyond a purely Austrian context.

Comment 1:

It was difficult for the author to obtain a clear description of the aims assigned to the research group. For this reason it is not possible to review the results achieved by comparison with the objectives originally set, as the aims mentioned in the text were laid down a posteriori and have therefore necessarily been achieved. Would it not be desirable in future for these points to be established more clearly between the OECD and the research groups?

Comment 2:

To our knowledge there are three principles underlying the analysis of the study sequence.

a) analysis of the student intakes;
b) analysis of the study sequence within a given period of time, from a cross-section of the different intakes still present;
c) retrospective analysis of the behaviour of students who have either completed or given up their studies within a given period of time.

Model b) is certainly the easiest to introduce in that it requires no retrospective acquisition of information and its prospective value is greatest, since it always uses the latest available information in respect of each intake, which makes this model very sensitive to any institutional changes made at a given time. In addition, the problem of students who switch to other studies can be easily resolved.

Model c) supplements model b), but requires retrospective data. Admittedly, these data can sometimes be calculated very simply, even after the event (e.g. total duration of studies) and there is always the advantage of having all the students on hand, since they are still enrolled in the university.

Model a) is, in our opinion, the most difficult to introduce since it requires either a retrospective acquisition of information for students who often are no longer enrolled in the university, or an extremely long wait until the last member of the intake has completed all his studies. As a result, the information is generally out of date at the time of its publication and is no longer of much use in the operational context. Finally, it should be pointed out that the problem of students who switch to other studies is extremely difficult to resolve since the intake is subdivided, like the branches of a tree, into a great many ramifications that cannot be quantified statistically.

Yet it is this last model which was chosen by Linz and it may be wondered whether some better justification should not have been found for this choice. It is apparent that practically no attempt was made to tackle the problem of students who switch to other studies and that at the end of the exercise 38 per cent of the students were still enrolled without having completed their studies, which appreciably reduces the size of the statistical population actually observable.

Comment 3:

The very restricted size of the statistical population observed (609 students, of whom 38 per cent had not yet completed their studies), when further divided into sub-groups, makes the statistical significance of the results observed somewhat unreliable. It therefore becomes desirable to apply the same models to much more extensive populations, and thereby provide better justification for three hypotheses that seem fundamental to further developments, namely:

1) the behaviour of the students remains roughly constant;
2) there are indicators which make it possible to identify clearly the different groups of behaviour;
3) the pace of studies and the quality of results are strongly correlated and may be interpreted as a single aggregate factor.

Comment 4:

The "successful", "slower" and "failed" student categories are identified by reference to a study programme, which would mean that in the absence of such a programme students could no longer be divided into categories.

It therefore occurred to us to supplement the model proposed with a module that would make it possible to identify these three behaviour groups statistically on the basis of effective data. This system could then be extended to nearly all types of studies, provided that the student were able, if not obliged, to report more or less regularly from the onset of studies.

The forecasting models would then be based on a student/student group comparison, rather than on a student/study programme comparison. The comparison of the behaviour groups thus determined with the study programmes in operation would make it possible to detect any distortions, and might serve as a basis for institutional decision-making in the future.

Comment 5:

With this last assumption, it may be wondered whether the "successful"/"slower" distinction would be maintained in its present form or whether one would not end up, for example, with a "success"/"failure" concept, successes being expressed as a distribution of probability over time.

Comment 6:

The concepts of success and failure are defined solely in terms of whether or not a degree is obtained. If it were to be made institutionally possibly for a student to embark on a course of study having specified at the outset that he did not wish to obtain a degree (it therefore being in his interest to specify this), the compatibility of the model would be extended to other universities which admit external students, trainees, persons who simply wish to undergo vocational retraining, etc. There can be no doubt that a possibility of this kind would have also had an influence on the figures at Linz, where it is mentioned that failures in a certain batch occur among relatively older people who are also engaged in some professional activity.

Comment 7:

The use of the "cluster" method is original and could certainly be applied in studying the average behaviour of students in various institutions of higher education (see Comment 4). In the present report it would have been desirable to have a general table showing all the clusters in relation to one another. The results would certainly confirm Comment 5. The small number of students involved is a handicap but the method could be used in other institutions of higher education to establish a relationship between failures and fields of study, for instance.

Comment 8:

If the hypotheses of behavioural stability and differentiation of groups could be verified on a large scale, it seems intuitively evident that a student should be able to be assigned to a behavioural group. It also seems that the choice of a method, once the basic data are the same, becomes a factor of secondary importance. Might it not then be preferable to use the variance model rather than the friction model, since the former would enable comparisons to be made either with the study programmes or with the groups of students observed.

Comment 9:

In order to prove the significance of a forecast, it would be desirable to relate the result of forecasts to the result that would have been obtained through a random effect.

From this point of view, it seems that the results mentioned in the study are not as conclusive as they have been made out to be. These qualified results are certainly due to the smallness of the samples and we are convinced that the forecasting model could still be greatly improved if the basic figures were more reliable.

Comment 10:

It has been clearly demonstrated that the conditions at Linz as regards premises are so "ideal" that the premises cannot have had any influence on the results of studies. On the other hand, it may be wondered whether an analysis of the marking systems of the different examiners might not show that some adjustments were in order; this question might perhaps have been taken a little further.

Comment 11:

It should also be an easy matter to register negative examination results by administrative arrangements or computerisation. Knowledge of these results would perhaps have improved forecasting possibilities.

Comment 12:

The planning and creation of the data bank compels admiration considering the limited material means available.

The description of the study programmes is ingenious and this file will obviously fulfil an important function.

On the other hand, it certainly seems that the students and studies system as a whole is relatively isolated from the other components of a university information system.

The same may surely be said of the link-up with the operational systems which are so important for the purposes of institutionalisation. It is a pity that this admirable programmed system could not have remained operational beyond the period of observation set

for the exercise. It would have been interesting to observe the behaviour of the study programmes model over a number of years, assuming that the study programmes could have been modified from year to year, since we instinctively feel that this factor may not have been taken sufficiently into account.

Comment 13:

This lack of link-up with the other university information systems and with the operational systems is similarly apparent when it is proposed to create a model for a data bank covering the whole country. The author would like to warn against the precipitate introduction of a centralised system which would inevitably necessitate the centralisation of a great deal of other information. If such a system were also cut off from the operational systems, there would be a great danger of not obtaining reliable information and of upsetting the whole data processing project, as was possible at Linz with the transfer of just one person from administration to teaching.

A centralised system should not underrate the efforts that have to be made at the level of each individual university. Before putting such a system into operation, it would seem more prudent to test it for two or three years in one of the universities, e.g. Linz or Vienna. From this standpoint, it can only be regretted that the system devised at Linz could not have continued to operate and been further developed.

On another level, it might then have been seen that verification by computer of all the conditions for admission to examinations and acceptance of a rating is a very cumbersome procedure and that arrangements should at least be made for dealing with the more unusual cases "manually". For it must not be forgotten that such a system has to be adjusted constantly to new conditions and new decision-makers, and the maintenance of this official information in the computer might well become so heavy a task that it could no longer be carried out correctly and in the required time in an operational system as well.

Comment 14:

The presence in this text of the detailed description of the function which the study programmes file can and must perform is apt to be somewhat bewildering to the reader, since he does not always appreciate the link between this question and the examination system. The same is true of the simulation model.

Conclusions

It would seem at first sight that the possibility of applying the Linz model depends on the existence of relatively well structured study regulations. On reflection, however, it might also be argued that the system, slightly amended, could be applied to any university, provided that the student were obliged to report before the end of his studies.

The conclusion which may be drawn is that the work should not be regarded as finished but should be pursued along the lines already mentioned:

- aplication of the system to other universities;
- verification of hypotheses over a sufficiently large and varied statistical population;
- investigation, through sample surveys, of criteria not objectively quantifiable in an administrative system, such as social environment, conditions of study and so forth;
- extension of the system to make it operational and ensure a link-up with the other components of a university information system;

- testing of the system in a university over a number of years.

Finally, the author would like to emphasize the wealth and originality of ideas contained in this work and to congratulate the Linz team on the results they have achieved in a comparatively short space of time.